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Supporting Information for

Constraining absolute plate motions since the Triassic

Michael G. Tetley[1,2,3*], Simon E. Williams[1], Michael Gurnis[2], Nicolas Flament[4], R. Dietmar. Müller[1]

[1]EarthByte Group, School of Geosciences, University of Sydney, NSW, Australia
[2]Seismological Laboratory, California Institute of Technology, Pasadena, California, USA
[3]Data61, CSIRO, Australian Technology Park, NSW, Australia
[4]School of Earth and Environmental Sciences, University of Wollongong, NSW, Australia

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Introduction

This supplementary material pack contains six (6) items. Item 6, the plate reconstruction provided (*Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma.zip*) requires the open-source GPlates software for visualization. GPlates can be downloaded for free from: https://www.gplates.org. A full set of tutorials on how to use GPlates can be found at: https://sites.google.com/site/gplatestutorials, with the manual/user documentation available for download from: https://www.gplates.org/docs.html.

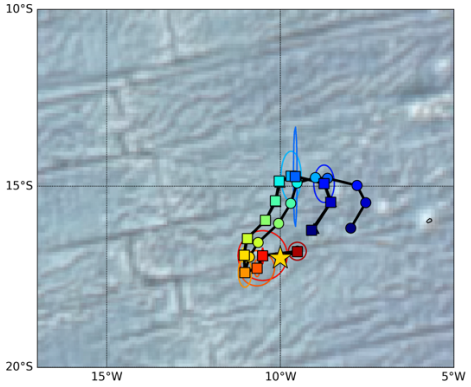
Table S1.xlsx
Calculated optimized APM model Euler rotations (as described in Table S1 caption below).

Table S2.xlsx
Calculated APM model global velocity statistics (as described in Table S2 caption below).

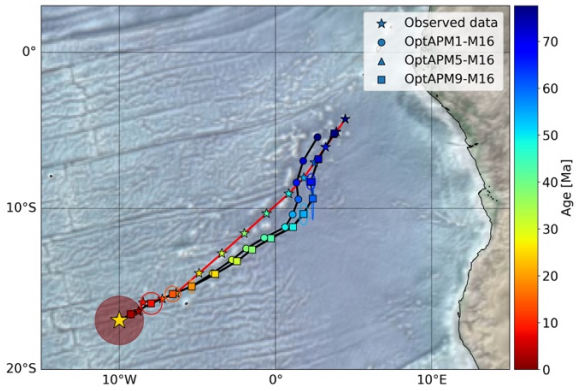
Table S3.xlsx
Predicted hotspot motions (as described in Table S3 caption below).

a)

(i) St Helena hotspot trail (OptAPM1-M16)

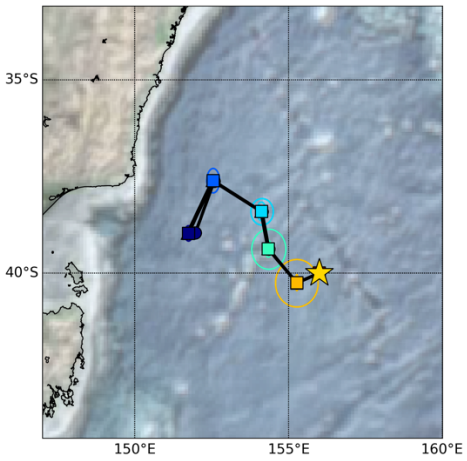


(ii) St Helena hotspot motion (OptAPM1-M16)

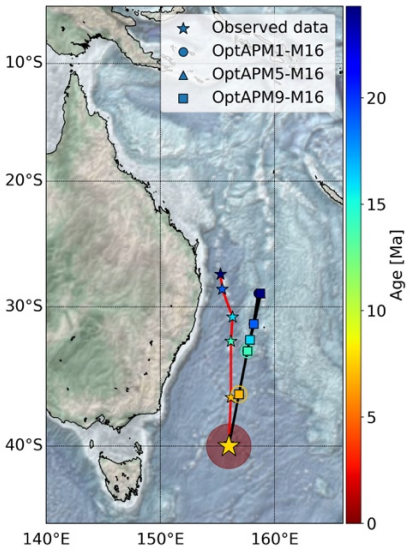


b)

(i) Tasmantid hotspot trail (OptAPM1-M16)

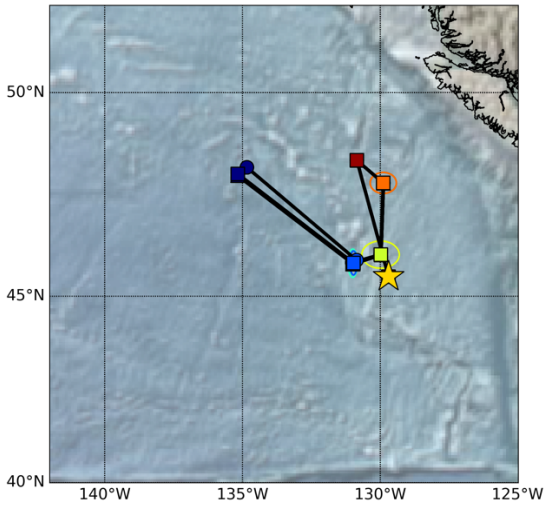


(ii) Tasmantid hotspot motion (OptAPM1-M16)

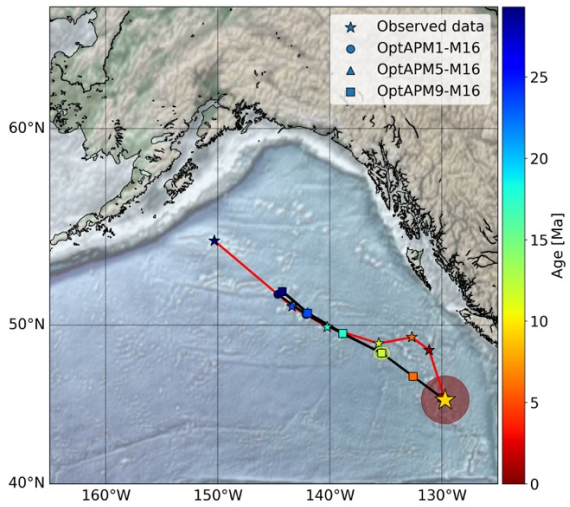


c)

(i) Cobb hotspot motions (OptAPM1-M16)

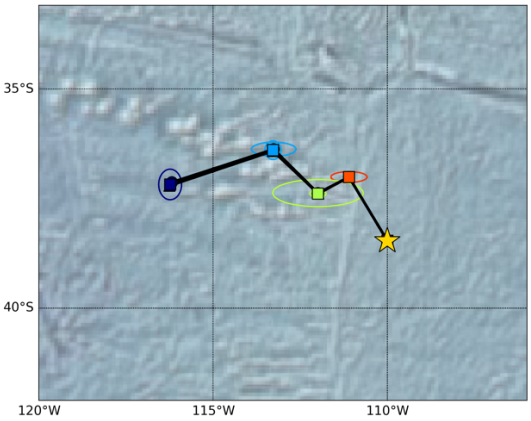


(ii) Cobb hotspot trails (OptAPM1-M16)

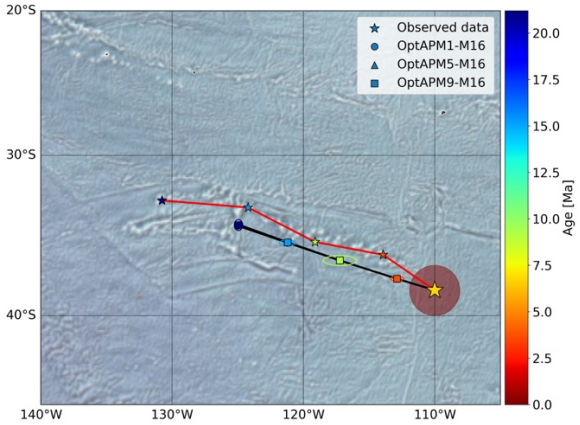


d)

(i) Foundation hotspot trail (OptAPM1-M16)

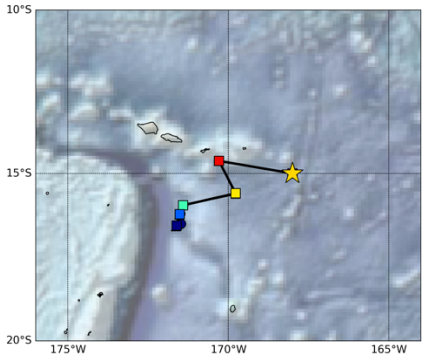


(ii) Foundation hotspot motion (OptAPM1-M16)



e)

(i) Samoa hotspot trail (OptAPM1-M16)



(ii) Samoa hotspot motion (OptAPM1-M16)

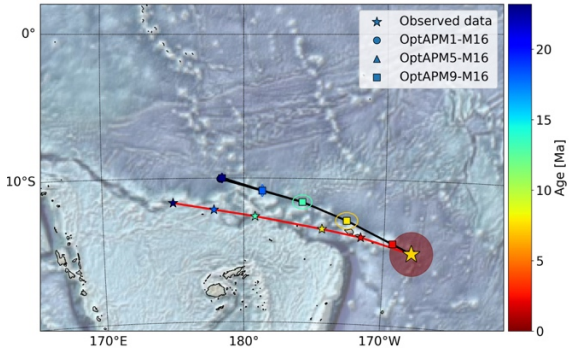
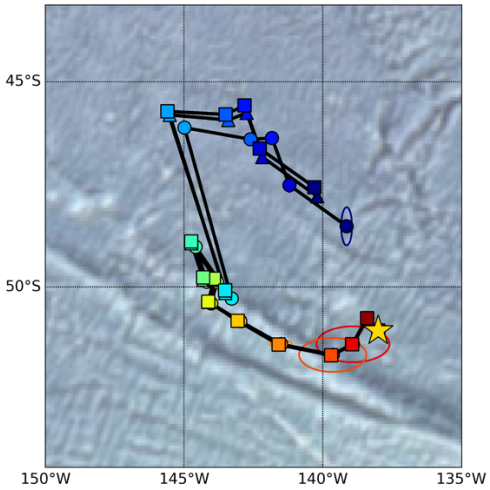


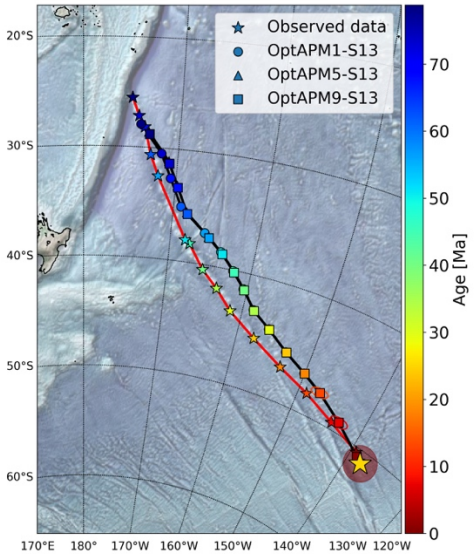
Figure S1. Predicted hotspot trails for APM models OptAPM1-M16, OptAPM5-M16 and OptAPM9-M16 for a) St Helena, b) Tasmantid, c) Cobb, d) Foundation and e) Samoa. Panel (i) for each show estimated independent hotspot motion paths derived from fixed-hotspot track prediction and interpolated volcanic observations misfit. Panel (ii) for each show prediction hotspot trails. Ellipses are colour-coded by observation age and represent calculated model geographic uncertainties. Red line marks the resulting hotspot track when the fixed-hotspot trail prediction is corrected using the estimated hotspot motion model. Stars represent interpolated seafloor volcanic observations. Large gold star is estimated present day location of hotspot. Red circle represents approximate present-day hotspot locations with an estimated 2º uncertainty ellipse. Paths overlay ETOPO1 [*Amante and Eakins,* 2009] and global marine gravity [*Andersen et al.,* 2010]. Hotspot motion and predicted trail plots for Louisville, Hawaii, Réunion, and Tristan are presented in Figure 8. the main text.

a)

(i) Louisville hotspot motions (OptAPM1-S13)

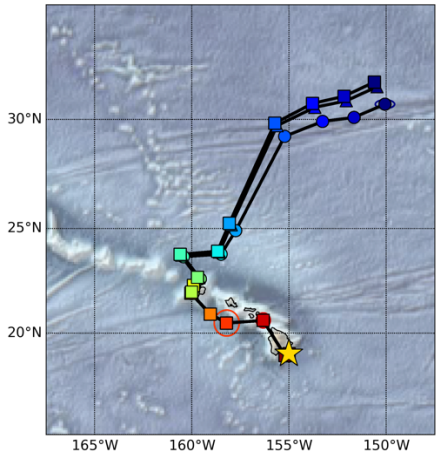


(ii) Louisville hotspot trail (OptAPM1-S13)

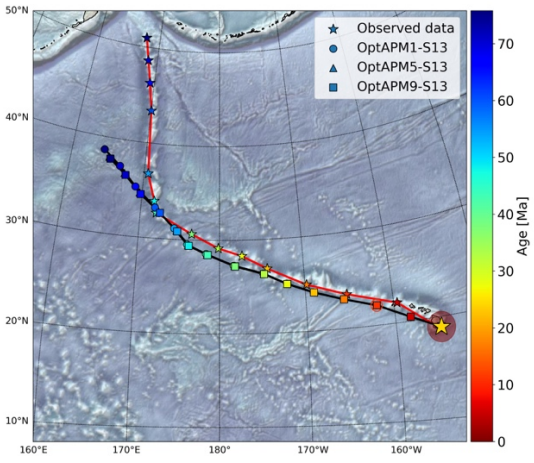


b)

(i) Hawaii hotspot motions (OptAPM1-S13)

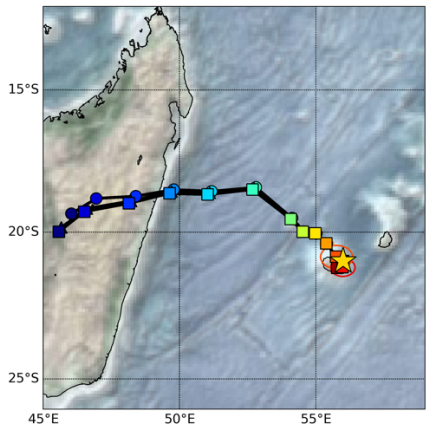


(ii) Hawaii hotspot trails (OptAPM1-S13)

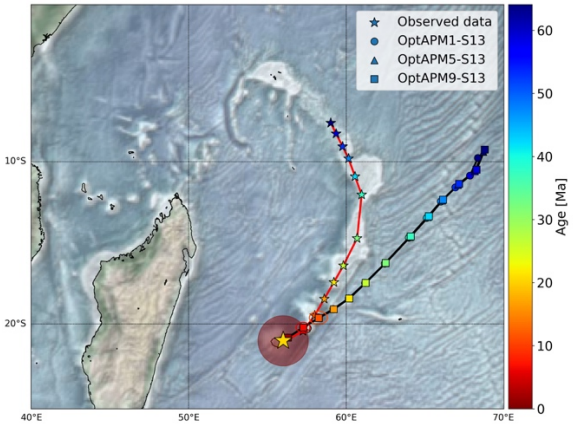


c)

(i) Réunion hotspot motions (OptAPM1-S13)

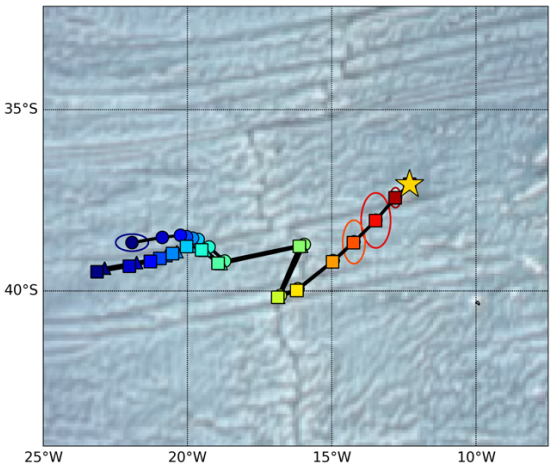


(ii) Réunion hotspot trails (OptAPM1-S13)

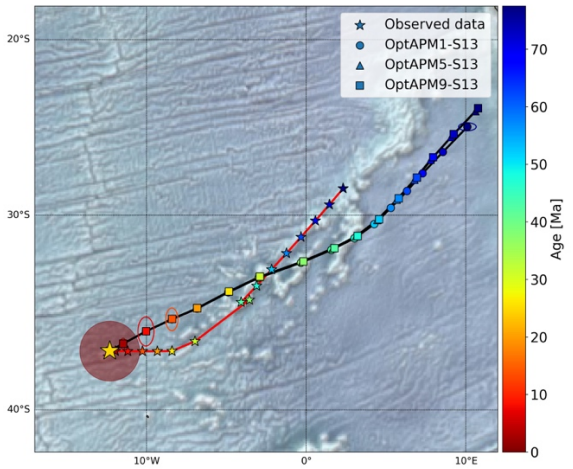


d)

(i) Tristan hotspot motions (OptAPM1-S13)

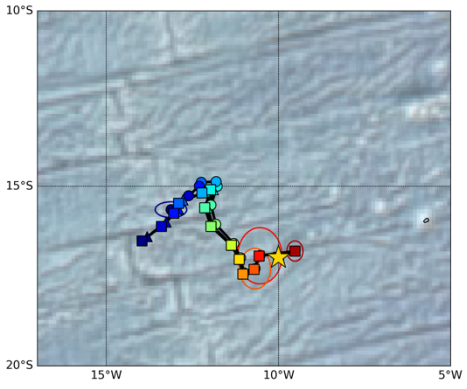


(ii) Tristan hotspot trails (OptAPM1-S13)

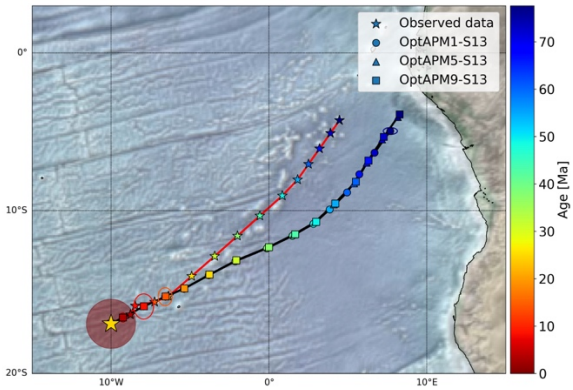


e)

(i) St Helena hotspot motions (OptAPM1-S13)

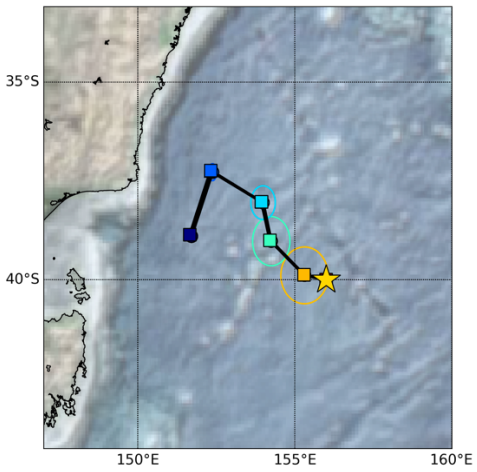


(ii) St Helena hotspot trails (OptAPM1-S13)

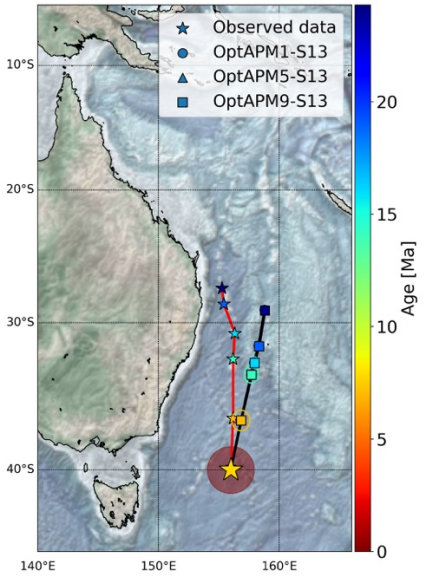


f)

(i) Tasmantid hotspot motions (OptAPM1-S13)

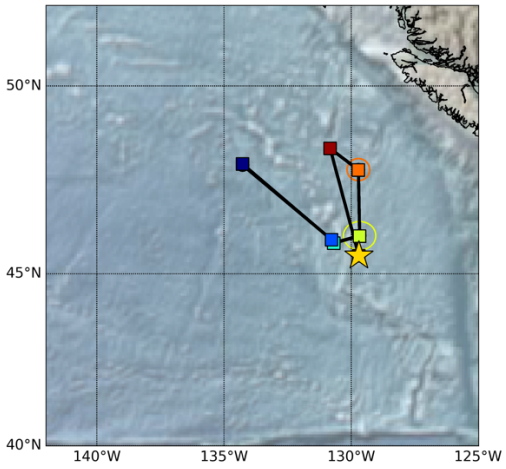


(ii) Tasmantid hotspot trails (OptAPM1-S13)

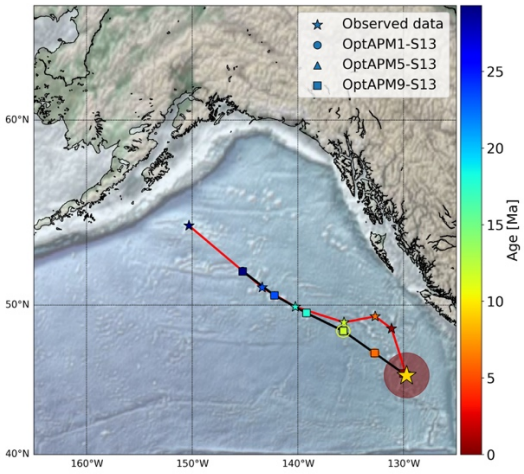


g)

(i) Cobb hotspot motions (OptAPM1-S13)



(ii) Cobb hotspot trails (OptAPM1-S13)



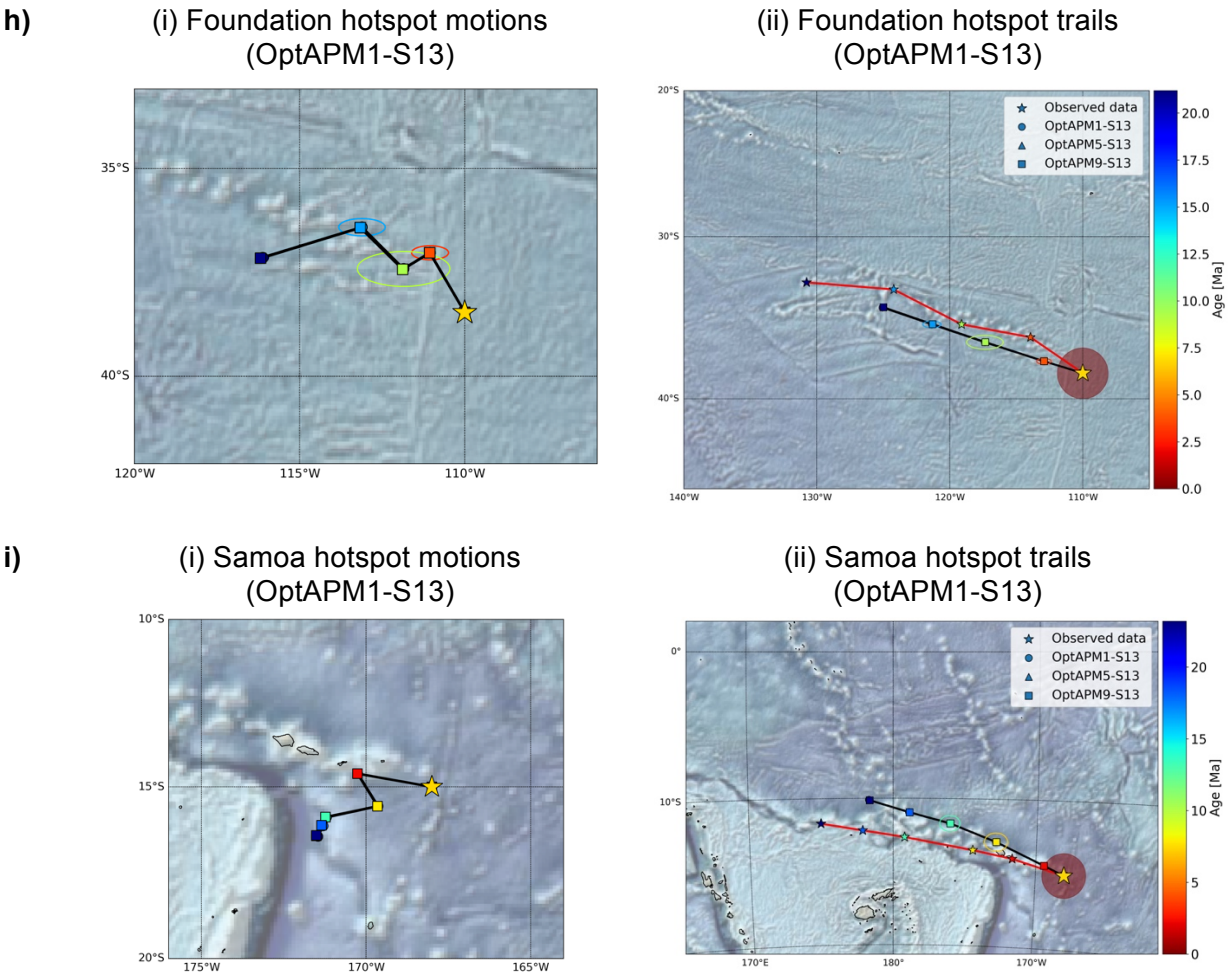


Figure S2. Predicted hotspot trails for APM models OptAPM1-S13, OptAPM5-S13 and OptAPM9-S13 for a) Louisville, b) Hawaii, c) Réunion, d) Tristan, e) St Helena, f) Tasmantid, g) Cobb, h) Foundation and i) Samoa. Panel (i) for each show estimated independent hotspot motion paths derived from fixed-hotspot track prediction and interpolated volcanic observations misfit. Panel (ii) for each show prediction hotspot trails. Ellipses are colour-coded by observation age and represent calculated model geographic uncertainties. Red line marks the resulting hotspot track when the fixed-hotspot trail prediction is corrected using the estimated hotspot motion model. Stars represent interpolated seafloor volcanic observations. Large gold star is estimated present day location of hotspot. Red circle represents approximate present-day hotspot locations with an estimated 2º uncertainty ellipse. Paths overlay ETOPO1 [*Amante and Eakins,* 2009] and global marine gravity [*Andersen et al.,* 2010].

Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma.zip
New plate reconstruction model for the 220-0 Ma. Optimized model OptAPM9-M16 (constrained by net lithospheric rotation minimization) applied to the Müller et al. (2016) plate reconstruction, with all plate boundaries and topologies corrected for the new APM. Zip file contains four (4) GPlates files required to interrogate model using the GPlates software:

Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma_Coastlines.gpml
Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma_PlateBoundaries.gpml
Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma_Topology_BuildingBlocks.gpml
Tetley_etal_OptAPM9-M16_PlateReconstruction_220-0Ma.rot

Table captions

Table S1. List of all APM models produced this study derived from both the M16 and S13 RPM models. *Plate ID* = GPlates plate ID for the African plate as used in both M16 and S13 published models, *Age* = Euler rotation pole age, *Latitude* = Euler rotation pole latitude, *Longitude* = Euler rotation pole longitude and *Angle* = Euler rotation pole magnitude.

Table S2. Calculated APM model global velocity statistics in mm/yr. APM = Absolute plate motion model, Block = continental block used in RMS calculation, Age = Age range for comparison in Ma, *Min* = path minimum velocity, *Max* = path maximum velocity, μ = path mean velocity, M = path median velocity, G_{σ}^{2} = path velocity gradient variance, $\sum G$ = sum of velocity gradients, σ = path velocity standard deviation, and η = number of samples. Values in bold represent the lowest value of all tested APM models for the given time range. *Global** is the calculated mean of all continental blocks and represents a summary of the respective APM model global velocity behaviour.

Table S3. Estimated independent absolute motion paths of hotspots using OptAPM1-M16 and OptAPM1-S13. *Latitude* = estimated motion path paleolatitudes, *Longitude* = estimated motion path paleolongitudes, *Period* = approximate period for each path motion velocity calculation, *Velocity* = estimated hotspot path segment velocity in mm per million years.